

## **AMENDMENTS TO THE CLAIMS**

1. (Original): A mass transfer column comprising:

an external shell defining an open internal region;

a plurality of return contact trays and centrifugal contact trays positioned in an alternating and vertically spaced apart relationship within the open internal region,

wherein each said return contact tray comprises a tray deck having at least one opening for removing liquid from an upper surface of said return tray deck and a plurality of vapor passages for allowing vapor to flow upwardly through said return tray deck to interact with liquid on said upper surface of said return tray deck,

wherein each said centrifugal contact tray comprises a tray deck having an upper surface, a periphery and a plurality of vapor passages for allowing vapor to flow upwardly through said centrifugal tray deck to interact with liquid on said upper surface of said centrifugal tray deck;

at least one center downcomer extending downwardly at said opening in said return tray deck, said center downcomer having a lower discharge outlet spaced above said centrifugal contact tray deck for feeding said liquid onto said centrifugal contact tray deck; and

at least one annular downcomer extending downwardly at said periphery of said centrifugal contact tray deck and having a lower discharge outlet spaced above said return tray deck for feeding said liquid onto said return tray deck,

wherein at least one of said centrifugal contact trays is positioned a greater distance above an adjacent one of said return contact trays than a distance at least one of said return contact trays is positioned above an adjacent one of said centrifugal contact trays.

2. (Original): The mass transfer column of claim 1, wherein said vapor passages are valves.

3. (Currently amended): The mass transfer column of claim 1, wherein said valves are oriented to provide the desired directional push to the liquid flowing across said tray deck.

4. (Original): The mass transfer column of claim 1, wherein said vapor passages are one of louvers and sieve holes.

5. (Original): The mass transfer column of claim 1, further comprising:  
a rotation-inducing element within said center downcomer to induce a rotational motion in the liquid exiting the center downcomer.

6. (Previously presented): The mass transfer column of claim 2, wherein said valves include covers inclined at an angle to the plane of one or both of said centrifugal or return tray deck to shield against liquid entry.

7. (Original): The mass transfer column of claim 1, wherein a single support ring supports one pair of contact trays.

8. (Original): The mass transfer column of claim 1, further comprising:  
one or more baffles positioned above said return contact tray to impede said liquid from jumping over said center downcomer.

9. (Original): A vapor-liquid contact tray unit comprising:

a plurality of return contact trays and centrifugal contact trays positioned in an alternating and vertically spaced apart relationship,

wherein each said return contact tray comprises a tray deck having at least one opening for removing liquid from an upper surface of said return tray deck and a plurality of vapor passages for allowing vapor to flow upwardly through said return tray deck to interact with liquid on said upper surface of said return tray deck,

wherein each said centrifugal contact tray comprises a tray deck having an upper surface, a periphery and a plurality of vapor passages for allowing vapor to flow upwardly through said centrifugal tray deck to interact with liquid on said upper surface of said centrifugal tray deck;

at least one center downcomer extending downwardly at said opening in said return tray deck, said center downcomer having a lower discharge outlet spaced above said centrifugal contact tray deck for feeding said liquid onto said centrifugal contact tray deck; and

at least one annular downcomer extending downwardly at said periphery of said centrifugal contact tray deck and having a lower discharge outlet spaced above said return tray deck for feeding said liquid onto said return tray deck,

wherein at least one of said centrifugal contact trays is positioned a greater distance above an adjacent one of said return contact trays than a distance at least one of said return contact trays is positioned above an adjacent one of said centrifugal contact trays.

10. (Original): The vapor-liquid contact tray unit of claim 9, wherein a single support ring supports one pair of contact trays.

11. (Currently amended): The ~~mass transfer column~~ vapor-liquid contact tray unit of claim 10, further comprising:

one or more baffles positioned above said return contact tray to impede said liquid from jumping over said center downcomer.

12. (Previously presented): A method of intermixing vapor and liquid streams in a mass transfer column having a plurality of return contact trays and centrifugal contact trays having tray decks with a plurality of vapor passages, at least one center downcomer and at least one annular downcomer, the method comprising:

(a) positioning a plurality of return contact trays and centrifugal contact trays in an alternating and vertically spaced apart relationship wherein at least one of said centrifugal contact trays is positioned a greater distance above an adjacent one of said return contact trays than a distance at least one of said return contact trays is positioned above an adjacent one of said centrifugal contact trays;

(b) directing a liquid stream into an inlet of one or more center downcomers;

(c) discharging substantially all of said liquid stream from said one or more center downcomers onto an underlying centrifugal contact tray deck;

(d) passing a vapor stream upwardly through vapor passages in said centrifugal contact tray, wherein said vapor stream interacts with said liquid stream on the surface of said centrifugal contact tray deck;

(e) flowing said liquid stream across said centrifugal contact tray deck toward a periphery of said centrifugal contact tray deck;

(f) directing at least part of said liquid stream into one or more annular downcomers at said periphery of said centrifugal contact tray;

(g) discharging substantially all of the part of the liquid stream from said one or more annular downcomers onto a return tray deck;

(h) passing a vapor stream upwardly through vapor passages of said return tray deck, wherein said vapor stream interacts with said liquid stream on the surface of said return tray deck;

(i) flowing the liquid stream across said return tray deck toward at least one opening therein; and

(j) repeating steps (a) through (i) on an underlying centrifugal and return contact tray.

13. (Previously presented): A mass transfer column comprising an external shell defining an open internal region and a plurality of vapor-liquid contact trays supported in the open internal region, comprising:

an external shell defining an open internal region;

at least one return contact tray and at least one centrifugal contact tray positioned in an alternating and vertically spaced apart relationship within the open internal region;

wherein said return contact tray comprises a tray deck having at least one opening for removing liquid from an upper surface of said return tray deck and a plurality of vapor passages for allowing vapor to flow upwardly through said return tray deck to interact with liquid on said upper surface of said return tray deck,

wherein said centrifugal contact tray comprises a tray deck having an upper surface, a periphery and a plurality of vapor passages for allowing vapor to flow upwardly through said centrifugal tray deck to interact with liquid on said upper surface of said centrifugal tray deck;

at least one center downcomer extending downwardly at said opening in said return tray deck, said center downcomer having a lower discharge outlet spaced above said centrifugal contact tray deck for feeding said liquid onto said centrifugal contact tray deck;

at least one annular downcomer extending downwardly at said periphery of said centrifugal contact tray deck and having a lower discharge outlet spaced above said return tray deck for feeding said liquid onto said return tray deck; and

one or more baffles positioned above said return contact tray in vertically spaced relationship to the latter to impede liquid from jumping over said center downcomer.

14. (Original): The mass transfer column of claim 13, wherein said baffle is a cone.

15. (Original): The mass transfer column of claim 13, wherein said baffle comprises curved deflecting surfaces.

16. (Original): The mass transfer column of claim 13, wherein said baffle comprises individual froth collector plates.

17. (Previously presented): A vapor-liquid contact tray unit comprising:  
at least one return contact tray and at least one centrifugal contact tray positioned in an alternating and vertically spaced apart relationship;

wherein said return contact tray comprises a tray deck having at least one opening for removing liquid from an upper surface of said return tray deck and a plurality of vapor passages for allowing vapor to flow upwardly through said return tray deck to interact with liquid on said upper surface of said return tray deck,

wherein said centrifugal contact tray comprises a tray deck having an upper surface, a periphery and a plurality of vapor passages for allowing vapor to flow upwardly through said centrifugal tray deck to interact with liquid on said upper surface of said centrifugal tray deck;

at least one center downcomer extending downwardly at said opening in said return tray deck, said center downcomer having a lower discharge outlet spaced above said centrifugal contact tray deck for feeding said liquid onto said centrifugal contact tray deck;

at least one annular downcomer extending downwardly at said periphery of said centrifugal contact tray deck and having a lower discharge outlet spaced above said return tray deck for feeding said liquid onto said return tray deck; and

one or more baffles positioned above said return contact tray in vertically spaced relationship to the latter to impede liquid from jumping over said center downcomer.

18. (Currently amended): The ~~mass-transfer column~~ vapor-liquid contact tray unit of claim 17, wherein said baffle is a cone.

19. (Currently amended): The ~~mass-transfer column~~ vapor-liquid contact tray unit of claim 17, wherein said baffle comprises curved deflecting surfaces.

20. (Currently amended): The ~~mass-transfer column~~ vapor-liquid contact tray unit of claim 17, wherein said baffle comprises individual froth collector plates.

21. (Previously presented): A method of intermixing vapor and liquid streams in a mass transfer column having at least one return contact tray and at least one centrifugal contact tray having tray decks with a plurality of vapor passages, at least one annular downcomer and at least one center downcomer, the method comprising:

(a) flowing a liquid stream across a center contact tray toward a periphery of a centrifugal tray deck;

(b) passing a vapor stream upwardly through vapor passages in said centrifugal contact tray, wherein said vapor stream interacts with said liquid stream on the surface of said centrifugal tray deck;

(c) directing at least part of said liquid stream into an inlet of one or more annular downcomers at said periphery of said centrifugal contact tray;

(d) discharging substantially all of the part of said liquid stream from said one or more annular downcomers onto a return tray deck,

(e) flowing the liquid stream across said return tray deck toward at least one opening in said return tray deck;

(f) passing a vapor stream upwardly through vapor passages in said return tray deck, wherein said vapor stream interacts with said liquid stream on the surface of said return tray deck, wherein one or more baffles are positioned above said return contact tray in vertically spaced relationship to the latter to impede liquid from jumping over said center downcomer;

(g) directing at least part of said liquid stream into an inlet of one or more center downcomers; and

(h) discharging substantially all of the part of the liquid stream from said one or more center downcomers.

22. (Original): A mass transfer column comprising an external shell defining an open internal region and a plurality of vapor-liquid contact trays supported in the open internal region, comprising:

an external shell defining an open internal region;



at least one return contact tray and at least one centrifugal contact tray positioned in an alternating and vertically spaced apart relationship within the open internal region,

wherein said return contact tray comprises a tray deck having at least one opening for removing liquid from an upper surface of said return tray deck and a plurality of vapor passages for allowing vapor to flow upwardly through said return contact tray deck to interact with liquid on said upper surface of said return tray deck,

wherein said centrifugal contact tray comprises a tray deck having an upper surface, a periphery and a plurality of vapor passages for allowing vapor to flow upwardly through said centrifugal tray deck to interact with liquid on said upper surface of said centrifugal tray deck;

at least one center downcomer extending downwardly at said opening in said return tray deck, said center downcomer having a lower discharge outlet spaced above said centrifugal contact tray deck for feeding said liquid onto said centrifugal contact tray deck;

at least one annular downcomer extending downwardly at said periphery of said centrifugal contact tray deck and having a lower discharge outlet spaced above said return tray deck for feeding said liquid onto said return tray deck;

and a support ring attached to said column shell to support both the centrifugal and return tray.

23. (Original): A vapor-liquid contact tray unit comprising:

at least one return contact tray and at least one centrifugal contact tray positioned in an alternating and vertically spaced apart relationship,

wherein said return contact tray comprises a tray deck having at least one opening for removing liquid from an upper surface of said return tray deck and a plurality of vapor

passages for allowing vapor to flow upwardly through said return contact tray deck to interact with liquid on said upper surface of said return tray deck,

wherein said centrifugal contact tray comprises a tray deck having an upper surface, a periphery and a plurality of vapor passages for allowing vapor to flow upwardly through said centrifugal tray deck to interact with liquid on said upper surface of said centrifugal tray deck;

at least one center downcomer extending downwardly at said opening in said return tray deck, said center downcomer having a lower discharge outlet spaced above said centrifugal contact tray deck for feeding said liquid onto said centrifugal contact tray deck;

at least one annular downcomer extending downwardly at said periphery of said centrifugal contact tray deck and having a lower discharge outlet spaced above said return tray deck for feeding said liquid onto said return tray deck;

and a support ring attached to said column shell to support both the centrifugal and return tray.

24. (Previously presented): A method of intermixing vapor and liquid streams in a mass transfer column having at least one return contact tray and at least one centrifugal contact tray having a tray deck with a plurality of vapor passages, at least one annular downcomer and at least one center downcomer, the method comprising:

(a) flowing a liquid stream across a centrifugal contact tray toward a periphery of said centrifugal tray deck;

(b) passing a vapor stream upwardly through vapor passages in said centrifugal contact tray, wherein said vapor stream interacts with said liquid stream on the surface of said centrifugal tray deck;

(c) directing at least part of said liquid stream into an inlet of one or more annular downcomers at said periphery of said centrifugal contact tray;

(d) discharging substantially all of the part of said liquid stream from said one or more annular downcomers onto a return tray deck, wherein said return tray and said centrifugal tray are supported by a single support ring attached to the column shell;

(e) flowing the liquid stream across said return tray deck toward at least one opening in said return tray deck;

(f) passing a vapor stream upwardly through vapor passages in said return tray deck, wherein said vapor stream interacts with said liquid stream on the surface of said return tray deck;

(g) directing at least part of said liquid stream into an inlet of one or more center downcomers; and

(h) discharging substantially all of the part of the liquid stream from said one or more center downcomers.

25. (New): A mass transfer column comprising an external shell defining an open internal region and a plurality of vapor-liquid contact trays supported in the open internal region, comprising:

an external shell defining an open internal region;

at least one return contact tray and at least one centrifugal contact tray positioned in an alternating and vertically spaced apart relationship within the open internal region;

wherein said return contact tray comprises a tray deck having at least one opening for removing liquid from an upper surface of said return tray deck and a plurality of vapor

passages for allowing vapor to flow upwardly through said return tray deck to interact with liquid on said upper surface of said return tray deck,

wherein said centrifugal contact tray comprises a tray deck having an upper surface, a periphery and a plurality of vapor passages for allowing vapor to flow upwardly through said centrifugal tray deck to interact with liquid on said upper surface of said centrifugal tray deck;

at least one center downcomer extending downwardly at said opening in said return tray deck, said center downcomer having a lower discharge outlet spaced above said centrifugal contact tray deck for feeding said liquid onto said centrifugal contact tray deck;

at least one annular downcomer extending downwardly at said periphery of said centrifugal contact tray deck and having a lower discharge outlet spaced above said return tray deck for feeding said liquid onto said return tray deck; and

one or more conically-shaped baffles positioned above said return contact tray to impede liquid from jumping over said center downcomer.

26. (New): A vapor-liquid contact tray unit comprising:

at least one return contact tray and at least one centrifugal contact tray positioned in an alternating and vertically spaced apart relationship;

wherein said return contact tray comprises a tray deck having at least one opening for removing liquid from an upper surface of said return tray deck and a plurality of vapor passages for allowing vapor to flow upwardly through said return tray deck to interact with liquid on said upper surface of said return tray deck,

wherein said centrifugal contact tray comprises a tray deck having an upper surface, a periphery and a plurality of vapor passages for allowing vapor to flow upwardly

through said centrifugal tray deck to interact with liquid on said upper surface of said centrifugal tray deck;

at least one center downcomer extending downwardly at said opening in said return tray deck, said center downcomer having a lower discharge outlet spaced above said centrifugal contact tray deck for feeding said liquid onto said centrifugal contact tray deck;

at least one annular downcomer extending downwardly at said periphery of said centrifugal contact tray deck and having a lower discharge outlet spaced above said return tray deck for feeding said liquid onto said return tray deck; and

one or more conically-shaped baffles positioned above said return contact tray to impede liquid from jumping over said center downcomer.